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PTO/SB/05 (4/98)
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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))

Attorney Docket No.	SEA9274
First Inventor or Application Identifier	John Arthur Mount
Title	See 1 in Addendum
Express Mail Label No.	EL376422007US

jc530 U.S. PTO 09/494787 01/31/00

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

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1. [X] * Fee Transmittal Form *(e.g., PTO/SB/17)* *(Submit an original and a duplicate for fee processing)*
2. [X] Specification [Total Pages 17] *(preferred arrangement set forth below)*
   - Descriptive title of the Invention
   - Cross References to Related Applications
   - Statement Regarding Fed sponsored R & D
   - Reference to Microfiche Appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings *(if filed)*
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure
3. [X] Drawing(s) *(35 U.S.C. 113)* [Total Sheets 9]
4. Oath or Declaration [Total Pages]
   a. [X] Newly executed (original or copy)
   b. [ ] Copy from a prior application (37 C.F.R. § 1.63(d)) *(for continuation/divisional with Box 16 completed)*
      i. [ ] DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).

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5. [ ] Microfiche Computer Program *(Appendix)*
6. Nucleotide and/or Amino Acid Sequence Submission *(if applicable, all necessary)*
   a. [ ] Computer Readable Copy
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ACCOMPANYING APPLICATION PARTS

7. [ ] Assignment Papers (cover sheet & document(s))
8. [ ] 37 C.F.R.§3.73(b) Statement *(when there is an assignee)* [ ] Power of Attorney
9. [ ] English Translation Document *(if applicable)*
10. [ ] Information Disclosure Statement (IDS)/PTO-1449 [ ] Copies of IDS Citations
11. [ ] Preliminary Amendment
12. [X] Return Receipt Postcard (MPEP 503) *(Should be specifically itemized)*
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Addendum

1. AUTOMATED REGISTER DATA TRASFER RESPONSIVE TO ZONE TRANSITION EVENTS IN A DISC DRIVE

AUTOMATED REGISTER DATA TRANSFER RESPONSIVE TO ZONE TRANSITION EVENTS IN A DISC DRIVE

Related Applications

This application claims the benefit of U.S. Provisional Application No. 60/150,712 filed on August 25, 1999.

Field of the Invention

The present invention relates to data handling systems, and more particularly to those storing data on rotatable discs of the "zoned" type.

Background of the Invention

A diverse class of data storage systems use rotatable discs as recording media. Although these systems are usually categorized by the type of media (fixed/removable, optical/magnetic, etc.), some things are common to all. Basically, these systems use a lens, a magneto-resistive (MR) element, or another suitable head positioned adjacent a disc to read portions of concentric tracks on a disc, and associated electronics that control the generation of signals carrying digital data to be stored. Subsequently, the transitions stored on the disc surface are sensed so that the stored data can be retrieved.

As discussed in U.S. Pat. No. 4,799,112 ("Method and Apparatus for Recording Data") issued Jan. 17, 1989 to Bremmer et al., the performance of such a system can be improved by grouping each disc's tracks into annular zones, each of which has certain properties that are kept uniform. The annular zones are separated by zone boundaries, across which the controlled properties may change abruptly. Conventionally, these have

included such properties as circumferential bit density or data frequency. The Bremmer et al. patent discloses a circuit for implementing this approach to data storage optimization and further discloses a method for selecting the zone frequencies and track-to-zone assignments in a way that will result in a substantially constant error rate in the writing and subsequent reading of data on and from all tracks on the disc.

More recently, many disc drive applications have adopted configurations using storage discs with annular zones. Moreover, an increasing number of reading and writing subsystems in a disc drive have begun to operate differently, in a zone-dependent fashion. In particular, many modern disc drives use the drive's primary processor to update the head's operating parameters and/or read channel registers via a serial bus, bit by bit. Performing such updates in this manner burdens the primary processor significantly and sporadically, especially when the number of values to be updated exceeds ten and when the zone to be read from switches frequently. Unfortunately, this interferes significantly with the processor's ability to perform its other functions.

Summary of the Invention

Methods and devices of the present invention update operating parameters and/or read channel registers with a lesser burden on the disc drive's primary processor. Table values are retrieved, optionally manipulated, and then used to update operating parameters or other register values. Type I methods of the present invention perform updates via a parallel bus, optionally the same parallel bus that is conventionally used for transmitting user and servo data. This relieves congestion on the serial bus connecting the microcontroller to read channel circuitry, and may allow elimination of that serial bus in certain applications.

Type II methods of the present invention use a serial bus to perform updates, but differ from prior systems by retrieving values via a direct memory access (DMA) controller. The DMA controller can preferably retrieve values and perform the updates with a minimum of direction from the primary controller. This relieves the primary controller from mundane tasks it would otherwise have to perform on a zone transition event (ZTE). Note that a triggering ZTE need not be a head crossing a zone boundary, but may be a head switch, a servo interrupt routine (SIR) indicative of a long seek, or any of several other events associated with preparing to read data from a different zone.

The inventive devices presented below are distinct from the above methods, but are generally preferred over other structures which may be adapted for performing those methods. Each device includes a disc stack, an interface, a controller chip, and a channel chip, any or all of which may be merely conventional. Each further provides a memory containing a table indexed by zone identifiers and configured to be read in response to a zone transition event. The table is desirably on a memory chip nearby and accessible to a DMA controller on the controller chip.

Further features and benefits of the present invention will become apparent to one of ordinary skill upon a careful review of the following drawings and accompanying detailed description.

Brief Description of the Drawings

Fig. 1 shows a basic method of the present invention which operates upon several values stored in a table.

Fig. 2 is a schematic view of a printed circuit board assembly including a memory containing a value table indexed by a plurality of zone identifiers.

Fig. 3 is a schematic view of a disc drive of the present invention consistent with **Fig. 2**, showing another portion of the same PCBA.

Fig. 4 shows a physical view of the disc of **Figs. 2 & 3**, roughly to scale.

Fig. 5 shows a **Type I** method of the present invention using a non-return-to-zero (NRZ) bus.

Fig. 6 shows a **Type II** method for the present invention using a serial bus.

Fig. 7 shows a detailed method compatible with either **Type I** or **Type II**.

Fig. 8 shows a preferred method for creating tables for use with the present invention.

Fig. 9 shows a preferred method of retrieving user data according to the present invention.

Detailed Description

Numerous aspects of disc drive technology that are not a part of the present invention (or are well known in the art) are omitted for brevity, avoiding needless distractions from the essence of the present invention. These include (1) detailed mechanisms for the construction, selection, or movement of heads; (2) mechanisms for deriving a signal indicative of stable biasing, track following, or other signals indicative of readiness to transmit user data; and (3) _____ _____. Although the examples below show more than enough detail to allow those skilled in the art to practice the present invention, subject matter regarded as the invention is broader than any single example below. The scope of the present invention is distinctly defined, however, in the claims at the end of this document.

Fig. 1 shows a basic method of the present invention which operates upon several values stored in a table. **Fig. 2** shows table **230,** which includes blocks of stored values **229** indexed by a plurality of zone identifiers **228**. Zone identifiers are exemplified as integers starting from zero, as is conventional in the art. The method comprises steps **11 - 17** of **Fig. 1**, in which it is assumed that the location (and zone) of the data segment to be read is given. In step **12,** several values **229** indexed by zone identifier **228** are retrieved from table **230**. In step **14,** the values are transmitted across a bus to update several of the registers that control the read channel. The retrieving step **12** and the transmitting step **14** are optionally performed simultaneously or alternately in increments, preferably by DMA controller **220**. Active head(s) are positioned in the target segment's zone **50,** preferably by a seek operation performed concurrently with retrieving step **12** and transmitting step **14**. After the completion of the last of steps **12, 14,** and **15,** the target segment is be read **16**. Note that the method of **Fig. 1** may be performed repeatedly in reading a file with portions in more than one data zone.

Fig. 2 shows printed circuit board assembly (PCBA) **600** having a DMA controller **220** and a memory **240** containing a value table **230**. Depending on performance and price constraints, memory **240** may be an off-the-shelf memory chip or a circuit on the same chip as the DMA controller **220**. Table **230** contains several zone ID's **228** each associated with a block of values **229** in a predetermined sequence. The first values **231,251** in each block indicate head bias expressed in microamps, left-shifted two bits. Value **231** thus indicates that when reading from zone 0, the active read head should have a bias current of $1000.11_2 = 8.8$ microamps. Value **251** similarly indicates that when reading from zone two (zone ID = 2), the head bias should be 12.2 microamps.

Values **232** & **252** similarly express respective gain values of **170** and **145**. Values **233** & **253** similarly express sectors/track values of **92** and **46**.

Values **234** & **254** similarly express respective nominal frequency values (in Mbits/second) of **252** and **219**. Values **236** & **256** similarly express respective first-order filter coefficient values (scaled by bit-shifting) of **158** and **168**. Values **237** & **257** similarly express respective third-order filter coefficient values (scaled by bit-shifting) of **61** and **18**. Table values in devices of the present invention may also include read channel parameter or head-specific operating parameters such as write precompensation modes or current levels, bias offset values, phase offset values, flag register values, count values, clock modes, and the like. Further background concerning the adjustment of read channel register values such as pulse detector amplitude thresholds, filter coefficients, time constants, cutoff frequencies and the like can be found in U.S. Patent 5,642,244 ("Method and Apparatus for Switching Between Data and Servo Modes") issued June 24, 1997 to Okada et al. Further background concerning zone clock modes can be found in U.S. Patent 5,459,757 ("Timing and Gain Control Circuit for a PRML Read Channel") issued to Minuhin et al. on September 21, 1994. A preferred embodiment of the present invention updates a clock frequency parameter in preparation for reading data in a different zone.

Values **238** & **258** each contain a left-most bit one bit indicating time-critical data mode (e.g. for video data). In each case, the bit is zero, indicating that the data in zones 0 and 2 are integrity-critical (i.e. not time-critical). In a preferred embodiment of the present invention, error recovery sequences execute differently depending upon the value of the left-most bit in the first-listed byte of the values **229** in table **230**.

The other seven bits of values **238** & **258** contain these mode-identifying bits: one bit indicating constant density recording (CDR) mode; one bit indicating data compression mode; one bit indicating frequency acquisition mode; one bit indicating phase acquisition mode; one bit indicating skew compensation mode; and two bits indicative of M and N (explained below). Note that skew compensation mode is set (active) in

zones 0 and 2, but not in zone 1. This mechanism is used to indicate that the angle between the transducer and the track edges is greatest in zones 0 and 2, in the present embodiment. **Fig. 4** shows that transducer **470** traverses an arcuate path **402** that is least aligned with zone boundaries **563** in zones 0 and 2, which is why skew compensation is desirable there. In a preferred embodiment, the frequency or phase acquisition mode bits can be reset when slave IC **300** senses that accurate frequency or phase has been ascertained. Further detail about control systems making use of frequency and phase acquisition and maintenance modes is found in U.S. Patent 5,420,543 ("Method and Apparatus for Determining a Constant Gain of a Variable Oscillator") issued May 30, 1995 to Lundberg et al.

Concerning M and N, data on a disc surface is conventionally divided into "frames" (typically less than that which can fit in a track) each containing a number of sectors (an integer conventionally designated as "N") and also containing a number of servo marks (an integer conventionally designated as "M"). Further background relating to calculations sector and servo mark counts is found in U.S. Patent 5,768,043 ("Table Driven Method and Apparatus for Automatic Split Field Processing") issued to Nemazie et al. on June 16, 1998. In a preferred embodiment of the present invention, some of the retrieved data will be used to update operating parameters derived from M or N, M or N having values that differ across at least one zone boundary of a disc surface. Note that in the depiction of **Fig. 2**, M and N are encoded in just two bits to conserve space in the value table **230**. Each of these integers may alternatively be represented by a respective byte, where table space is at less of a premium.

Another reference articulating the use of mode initialization is U.S. Patent 5,559,645 ("Disk Recording Apparatus with Adaptive Window Adjusting") issued September 24, 1996 to Miyazawa et al., which exemplifies a mechanism for switching among four write precompensation

modes. A preferred method of the present invention includes steps of initializing a mode in response to a zone transition event by setting a mode switch and of resetting the mode switch in response to a signal indicative of stable biasing and/or track following.

Fig. 3 is a schematic view of a disc drive **100** of the present invention consistent with **Fig. 2**, comprising E-block **400**, disc stack **500**, and PCBA **600**. The PCBA includes a master IC **200** and a slave IC **300**. The master IC **200** contains a micro controller **210**, a sequencer **215**, and the DMA controller **220** (of **Fig. 2**). The slave IC **300** contains several registers **340**, at least some of which control the operation of the read channel. These IC's are operatively coupled to bus **360**. Affixed to E-block **400** are heads **460,461** each having a read transducer **470,471** and a plurality of operating parameters **440,441**. An interface **450** coupled between bus **360** and heads **460,461** is configured to provide a mechanism for head selection, many of which are known in the art. According to methods of the present invention explained below, register values are updated on zone transitions. In a preferred embodiment, some registers are only updated on a selected subset of zone transition events, such as those accompanied by a head switch. Interface **450** may optionally be a preamp chip having a head selection mechanism. Disc stack **500** includes discs **510** each having two recording surfaces **511,512**. Each surface **511** has a plurality of zones **520,521**. E-block **400** has a degree of freedom **401** that allows each transducer **470,471** to move across zone boundaries **563**.

Fig. 4 shows a physical view of the disc **510** of **Figs. 2** & 3, roughly to scale. Disc **510** has an inner diameter **556** and an outer diameter **557**. Transducer **470** traverses an arcuate radial path **402** between the inner diameter **558** and the outer diameter **559** of the data surface. The data surface is divided into several zones **520,521,522** bounded by zone boundaries **563**. Tracks **561,562** each contain several sectors **538**, at least some of which having servo sectors **539** between them. In the position

shown in **Fig. 4**, transducer **470** is positioned so that it can read track **561** as disc **510** rotates.

Suppose that a target sector **530** is desired to be read. E-block **400** is moved so that transducer **470** moves radially to the outermost zone **520** (Z0). The data rate (i.e. through transducer **470** and bus **360**) depends on both the spin speed **501** and position of transducer **470**. As **Fig. 4** shows, Z0 has many more sectors per track than Z2. Before reading data in target segment **530,** therefore, disc spin speed **501** must decrease and/or the data rate must increase. In a real-world disc drive, many operating parameters are desirably changed when preparing to read from a different zone (i.e. upon a "zone transition event").

Fig. 5 shows a **Type I** method of the present invention comprising steps **21** through **28**. Data is recorded onto a disc surface via a non-return-to-zero (NRZ) bus **22**. A part of the data is later retrieved via the bus **23,** after which the bus is used to update read channel registers **24** and head operating parameters **26**. A test is performed to ascertain whether the desired data has been retrieved **27**. This test optionally includes confirming that a decremented register indicative of bytes remaining to transfer has reached zero. If the transfer is not complete, another part of the data is retrieved via the NRZ bus **23**.

Fig. 6 shows a **Type II** method for the present invention comprising steps **31** through **38,** using a system comprising a serial bus operatively coupled to a preamp. Data is recorded onto the disc surface(s) via the serial bus and preamp **32,** and is later retrieved **33** the same way. After updating the nominal or initial disc stack spin speed via the serial bus **35,** another part of the recorded data is retrieved, also via the path through the serial bus and preamp **37**.

Fig. 7 shows a detailed method compatible with either **Type I** or **Type II**, comprising steps **41** through **49**. This method treats target ID values and target segment length values as given (i.e. predetermined). A

zone ID is derived from the target ID **42,** such as by an integer division, table lookup, or by other methods known in the art. The zone ID is used to retrieve an associated set of values from the table **43,** one of which is a bit density within that zone. Around the time that steps **42** and **43** are performed, a seek operation is initiated to begin moving a head toward the target track **44**. A preferred method of the present invention initiates mechanical steps such as step **44** without waiting for computational and memory-retrieval steps such as steps **42** and **43**.

Once a transducer is over the data and the system is ready to read **47,** the target segment is read **48**. Also, the segment length value is divided by the bit density value to derive a value indicative of estimated read duration **46**. This value is useful for a variety of purposes recognizable by one of ordinary skill in the art. In one exemplary system, a microprocessor is configured to ignore received user data until a "ready to read" signal is received and most of the estimated duration passes.

Preferred embodiments of the present invention respond to a zone transition event by reading from the memory via a DMA controller and by updating several registers. A preferred "zone transition event" is a sequencer command to move to another zone, because it allows a preparatory part of the read step **48** to occur early, usually before the head crosses any zone boundaries. Also note that the preparatory step of updating a register does not always cause a register value to change, if the read, measured, predetermined, or derived value is the same as the register's prior value.

A preferred embodiment of the present invention performs calculations upon at least some values read from the table before using the values to update register values. As a simple example, suppose that a block of data is needed from each of two adjacent zones Z_A and Z_B which have the same bit density (e.g. in bits per inch, BPI). Suppose further that a register value to be updated indicates the circumferential length of the

target segment in inches. After reading the block from zone Z_A, a suitable embodiment of the present invention updates the register value by retrieving the bit density associated with zone Z_B. Then, the embodiment multiplies divides the length (1 block) by the new bit density (after multiplying by the constant number of bits per block). This update does not result in a change of the register value.

Fig. 8 shows a preferred method for creating tables for use with the present invention, having steps **51** through **59**. A head is positioned in a first zone **52**. A signal is received from the head **53** and values indicative of the head's operation in the zone are derived **54**. These values may include an optimal bias current, precompensation values, or other operating parameters of inductive or magneto-resistive heads known in the art of disc drives. Additional background relating to deriving zone-dependent write current values is found in U.S. Patent 5,687,036 ("Selection of Optimum Write Current in a Disc Drive to Minimize the Occurrence of Repeatable Read Errors") to Kassab on November 11, 1997. Optimal values associated with the first zone are stored in a table, in a portion that is associated with that zone **56**. Next, optimal values for other zones and/or heads are similarly derived and stored **58**.

Fig. 9 shows a preferred method of retrieving user data according to the present invention, comprising steps **61** through **69**. Head motion in a radial direction begins, using servo feedback control **62**. A microcontroller instructs the DMA controller to execute a block retrieval to obtain a data rate value (R_{new}) and a bit density value (D_{new}) corresponding to the target track **63** from a value table. This execution step **63** is desirably performed with fewer than **10** commands from the microcontroller. Note that this is not possible for a microcontroller (like microcontroller **210** of **Fig. 3**) fetching and writing each value of a table with a large number of values.

Being thus freed from most tasks associated with updating register values and operating parameters on zone transition events, the

microcontroller of **Fig. 9** is able to serve other important functions (e.g. generate a servo control signal) simultaneously with the DMA transmitting data to update register values **64**. An initial value for the data channel sample rate is obtained as an integer number (n) times R_{new}. After passing into the target zone, the signal received from the active head is sampled at this rate **66**. Once the head is suitably positioned **67,** the target segment is read **68**.

By way of review, certain methods of the present invention are directed to retrieving a target data segment having a given track ID. First, a zone ID is derived from the track ID **42**. Values indexed by the zone ID are retrieved **43** and register values are updated in response to the retrieval **46**. After a seek operation moves the head to the track with the given track ID **44,47,** the target segment is read **48**.

Devices of the present invention may include a memory **230** containing several values **229** indexed by zone identifiers **228,** a controller chip **200** containing a microprocessor **210** and a DMA controller **220,** the DMA controller operatively coupled to the memory **230**. They may also include a channel chip **300** having several registers **340** and a bus **360** operatively coupled between an interface **450** and these chips **200,300**. If the device is a disc drive, it will further include at least one disc **510** which can be coupled to the interface **450** through a movable assembly (such as E-block **400**).

All of the structures and methods described above will be understood to one of ordinary skill in the art, and would enable the practice of the present invention without undue experimentation. It is to be understood that even though numerous characteristics and advantages of various embodiments of the present invention have been set forth in the foregoing description, together with details of the structure and function of various embodiments of the invention, this disclosure is illustrative only. Changes may be made in the details, especially in matters of structure and

arrangement of parts within the principles of the present invention to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed. For example, steps of the above methods can be reordered while maintaining substantially the same functionality, without departing from the scope and spirit of the present invention. In addition, although the preferred embodiments described herein are largely directed to fixed magnetic media, it will be appreciated by those skilled in the art that many teachings of the present invention can be applied to other systems without departing from the scope and spirit of the present invention.

Claims

What is claimed is:

1. In a storage system having a bus operatively coupled to a first controller chip and a first channel chip, the channel chip having several registers, the storage system also having a storage medium operatively coupled to the bus through a storage medium interface, a method for retrieving data recorded on a storage medium comprising steps of:

(a) retrieving a first portion of the recorded data via the bus;

(b) updating some of the registers via the bus; and

(c) retrieving a second portion of the recorded data via the bus.

2. The method of claim 1 in which the interface includes a read head, further comprising a step (d) of repositioning the storage medium interface with respect to the storage medium, between retrieving steps (a) and (c).

3. The method of claim 2 in which the interface has a plurality of operating parameters that are modified in updating step (b).

4. The storage system of claim 1 configured to perform the method of claim 1 in which the registers contain at least one read channel parameter value selected from the group consisting of: a precompensation value, a filter coefficient value, and a phase offset value.

5. The storage system of claim 1 configured to perform the method of claim 1 in which the registers contain at least one mode-indicative value.

6. In a storage system having a disc with at least two zones having zone identifiers Z_A and Z_B, an interface configured to read data in zone Z_A, a target segment in zone Z_B, a value table indexed by zone identifiers, a direct memory access (DMA) controller, a microprocessor coupled to the DMA controller, and several read channel registers each containing a value, a method comprising steps of:

(a) retrieving via the DMA controller several values indexed by zone identifier Z_B;

(b) updating at least some of the read channel register values from the retrieved values;

(c) reconfiguring the interface to read data in zone Z_B; and

(d) reading the target segment.

7. The method of claim 6 in which the target segment has a predetermined starting track number, further comprising a step of deriving zone identifier Z_B from the predetermined starting track number before retrieving step (a).

8. The method of claim 6 in which the interface includes at least one head, in which positioning step (c) includes a step of (c1) moving the at least one head radially across the disc, the moving step (c1) beginning before retrieving step (a) is complete.

9. The method of claim 8 in which moving step (c1) begins before retrieving step (a) begins.

10. The method of claim 6 in which zone Z_B has a corresponding data rate R_B that is not in common with zone Z_A, in which positioning step (c) includes a step of (c2) sampling a signal from the interface at an initial frequency that is an integer multiple of data rate R_B.

11. The method of claim 6 further comprising prior steps of:

(e) configuring the interface to read data in zone Z_B;

(f) receiving a signal from the interface;

(g) deriving several values indicative of the interface's performance in zone Z_B from the received signal; and

(h) storing some of the derived values in the value table each at a position associated with zone Z_B.

12. The method of claim 6 in which the storage system includes an integrated circuit comprising the microprocessor, and in which the retrieving step (a) comprises issuing at least one but fewer than 10 commands from the microprocessor to the DMA controller.

13. The method of claim 12 further comprising steps of:

(j) sensing position data from a servo sector via the interface; and

(k) deriving a servo control signal from the sensed position data with the microprocessor during step (b).

14. The storage system of claim 6 configured to perform the method of claim 6 further comprising a printed circuit board assembly including a memory containing the value table, the storage system comprising:

a master integrated circuit (IC) containing the microprocessor and the direct memory access (DMA) controller, the DMA controller being operatively coupled to the memory;

a slave IC containing the several read channel registers; and

a bus coupled between the master IC and the slave IC, the bus controllable by the DMA controller to perform updating step (b).

15. A disc drive comprising:

a disc stack comprising at least one disc;

an interface configured to read data from the at least one disc;

a memory containing several values indexed by zone identifiers;

a first controller chip containing a microprocessor and a direct memory access (DMA) controller, the DMA controller operatively coupled to the memory;

a first channel chip having several registers; and

a bus operatively coupled between the interface and the chips, the bus controllable by the DMA controller to read from the memory and to update several of the registers in response to a zone transition event.

AUTOMATED REGISTER DATA TRANSFER RESPONSIVE TO ZONE TRANSITION EVENTS IN A DISC DRIVE

Abstract of the Disclosure

Operating parameters and other read channel registers are updated with a lesser burden on the disc drive's primary processor. After a zone transition event, table values indexed by a zone identifier are retrieved from a memory, preferably by a direct memory access controller. In one method, updates are performed via the same NRZ bus that is used for transmitting user and servo data.

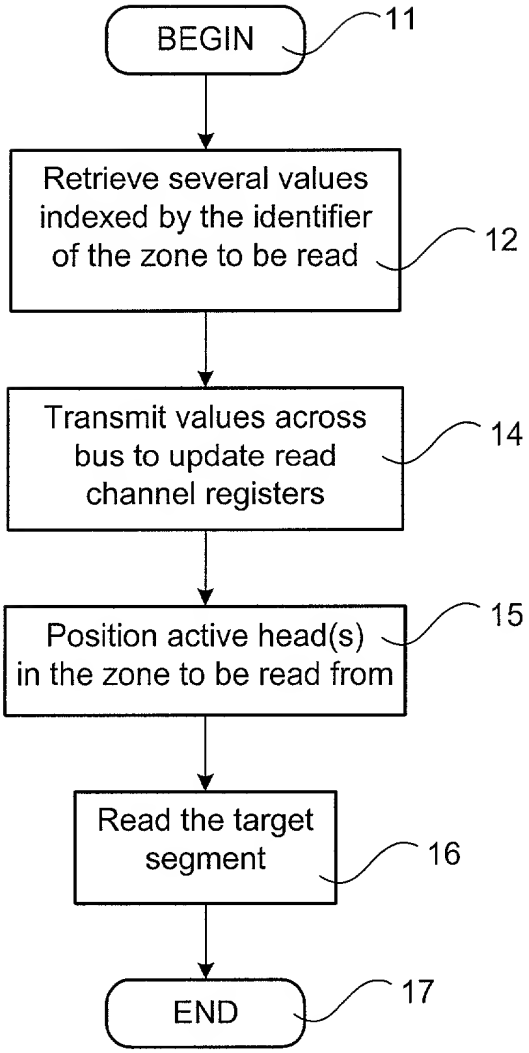
BEGIN
11
Retrieve several values indexed by the identifier of the zone to be read
12
Transmit values across bus to update read channel registers
14
Position active head(s) in the zone to be read from
15
Read the target segment
16
END
17

Fig. 1

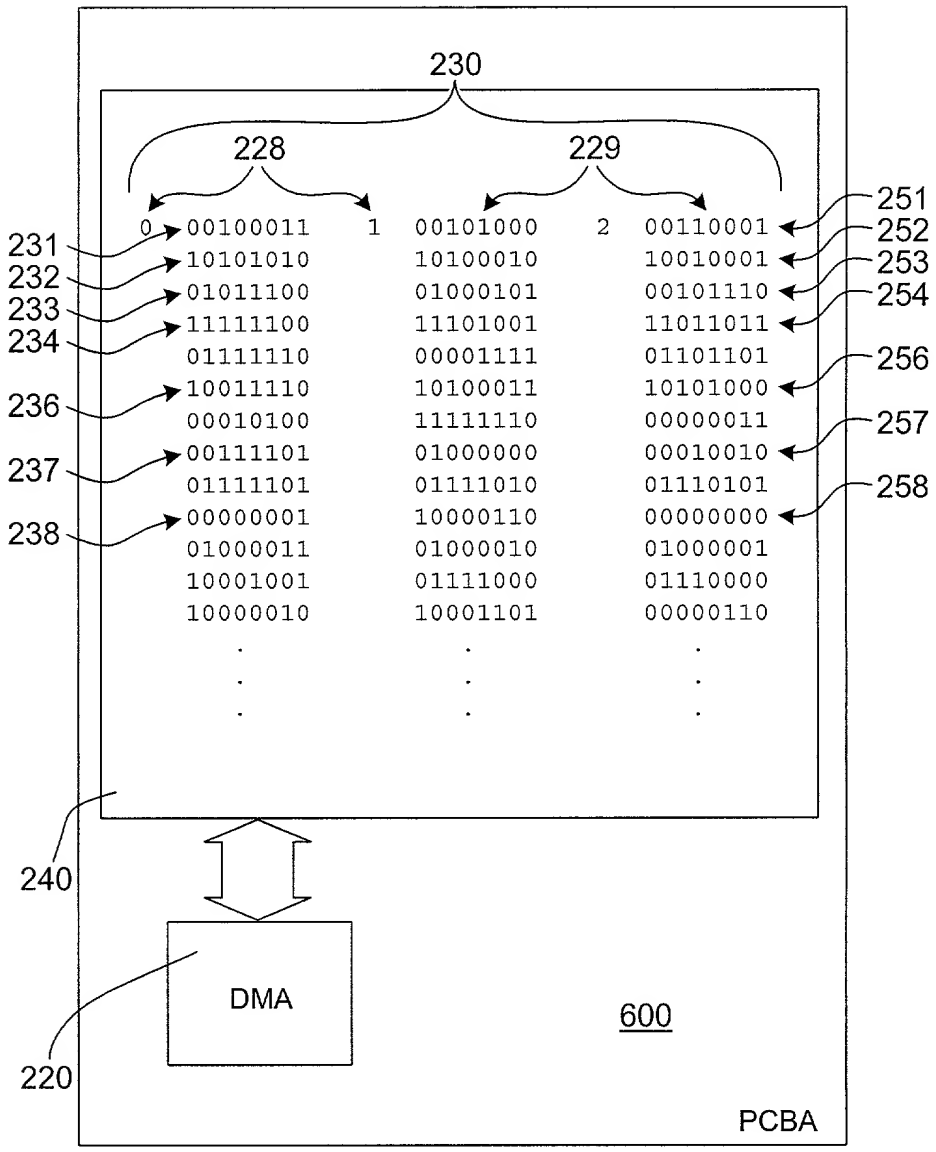
230
228
229
0
1
2
00100011
00101000
00110001
10101010
10100010
10010001
01011100
01000101
00101110
11111100
11101001
11011011
01111110
00001111
01101101
10011110
10100011
10101000
00010100
11111110
00000011
00111101
01000000
00010010
01111101
01111010
01110101
00000001
10000110
00000000
01000011
01000010
01000001
10001001
01111000
01110000
10000010
10001101
00000110
231
232
233
234
236
237
238
240
251
252
253
254
256
257
258
DMA
220
600
PCBA

Fig. 2

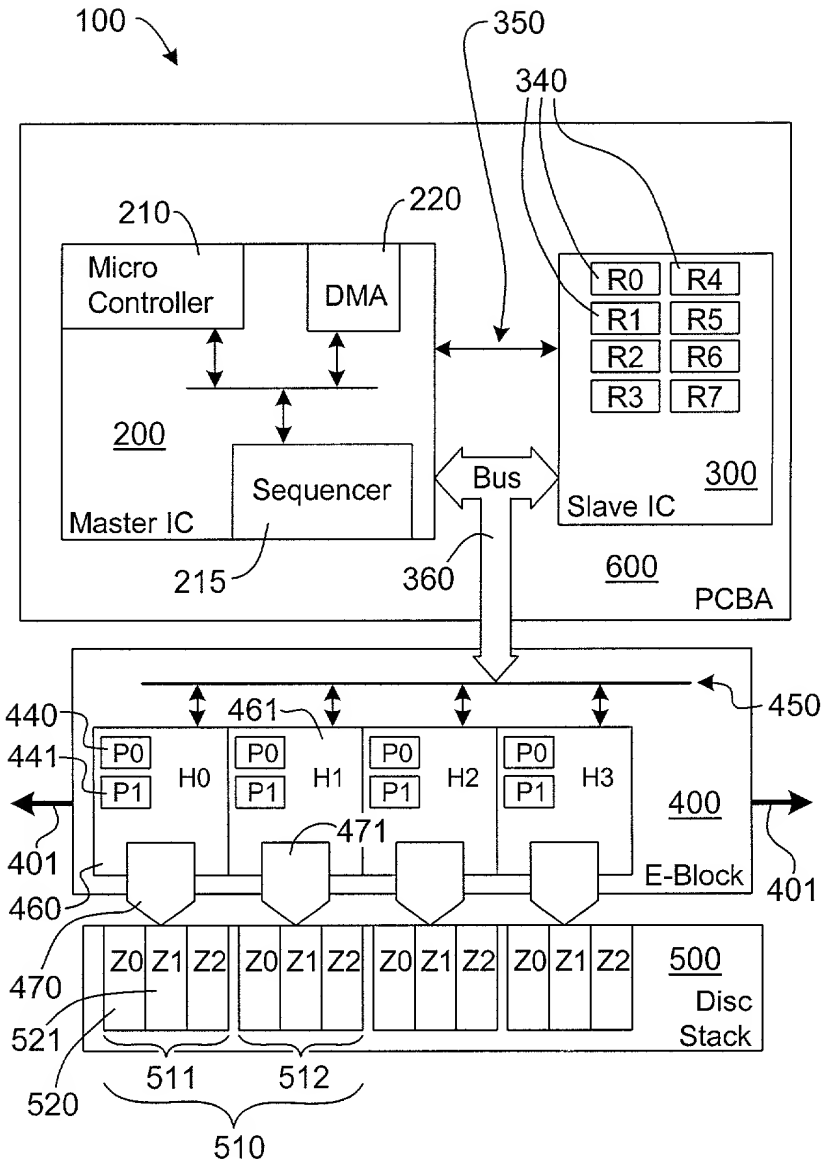
100
350
340
210
220
Micro Controller
DMA
R0
R1
R2
R3
R4
R5
R6
R7
200
Sequencer
Master IC
Bus
Slave IC
300
215
360
600
PCBA
440
441
461
450
P0
P1
H0
H1
H2
H3
400
471
401
460
E-Block
Z0 Z1 Z2
500
Disc Stack
470
521
520
511
512
510

Fig. 3

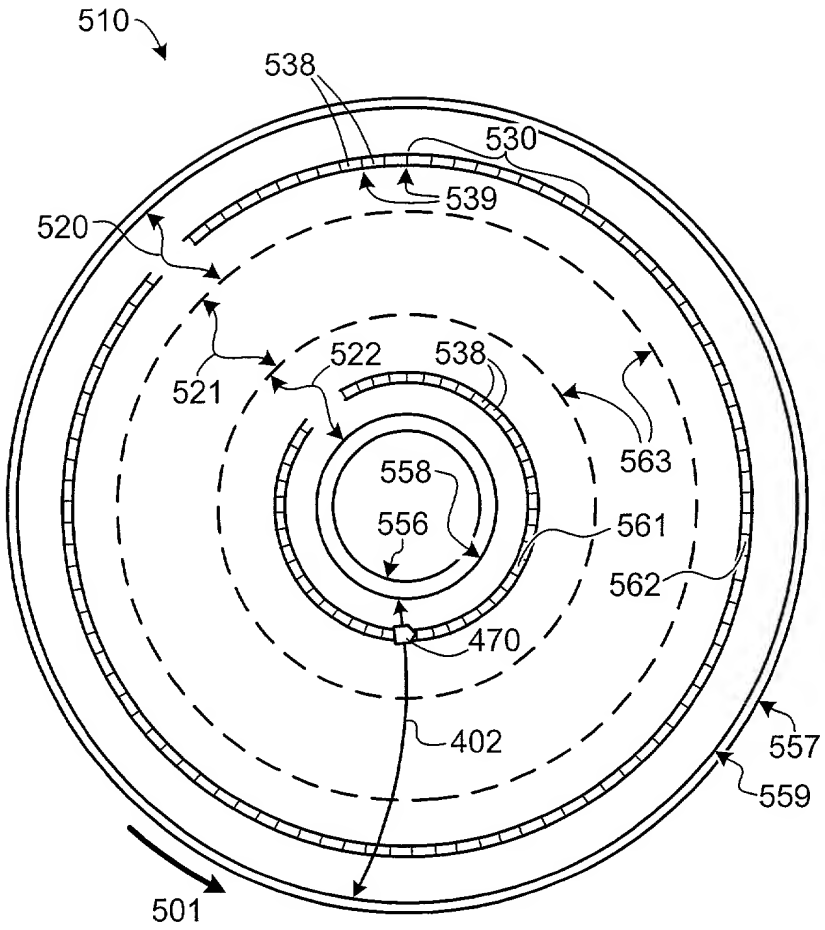
510
538
530
539
520
521
522
538
563
558
556
561
562
470
402
557
559
501

Fig. 4

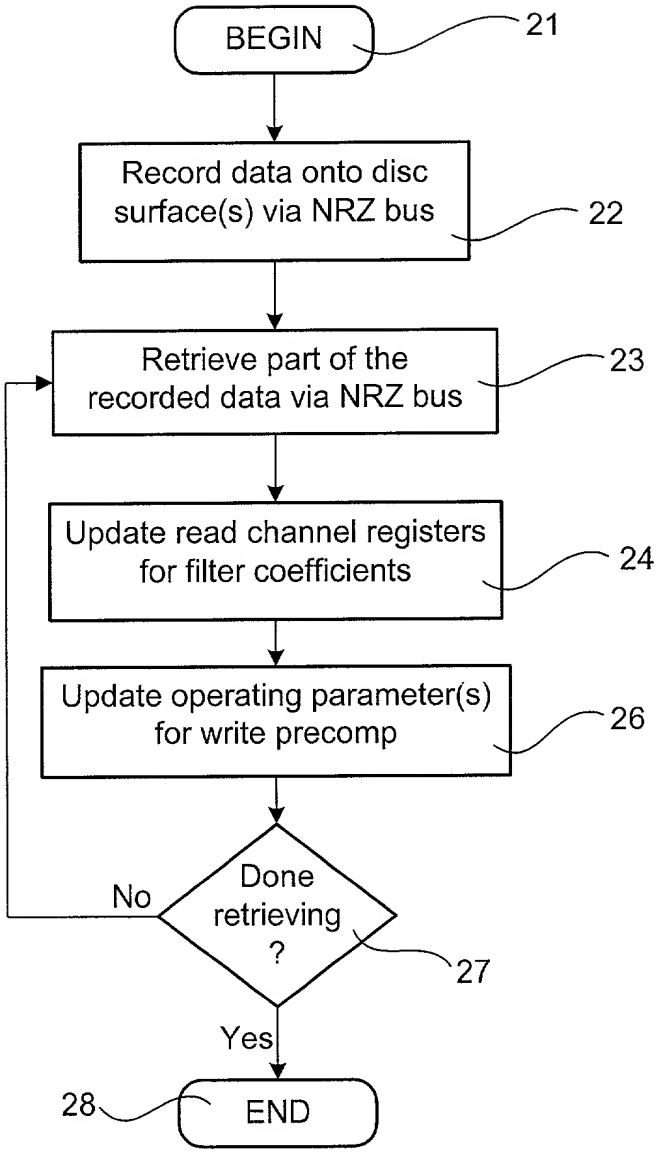
BEGIN
21
Record data onto disc surface(s) via NRZ bus
22
Retrieve part of the recorded data via NRZ bus
23
Update read channel registers for filter coefficients
24
Update operating parameter(s) for write precomp
26
Done retrieving ?
27
No
Yes
END
28

Fig. 5

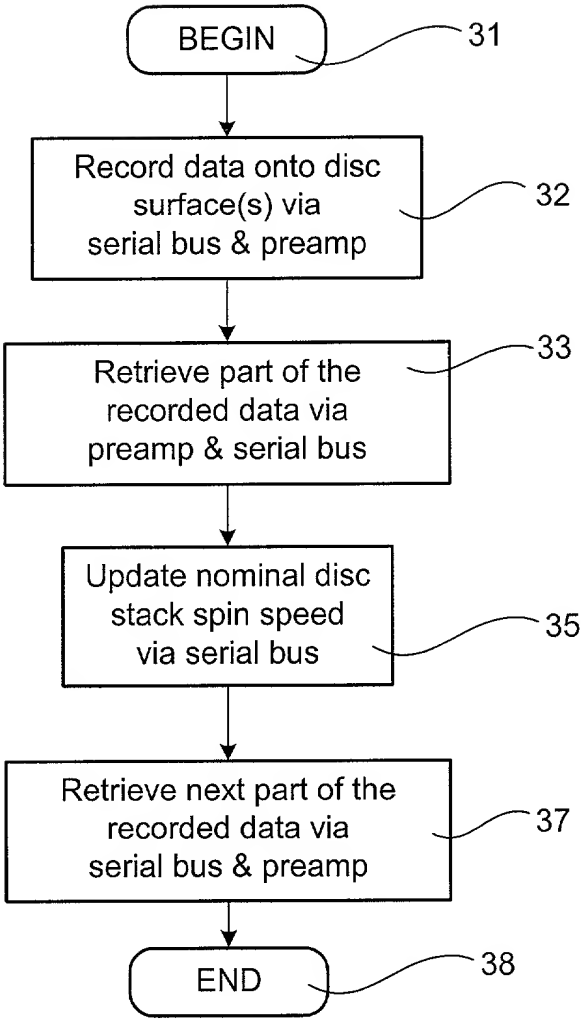
BEGIN
31
Record data onto disc surface(s) via serial bus & preamp
32
Retrieve part of the recorded data via preamp & serial bus
33
Update nominal disc stack spin speed via serial bus
35
Retrieve next part of the recorded data via serial bus & preamp
37
END
38

Fig. 6

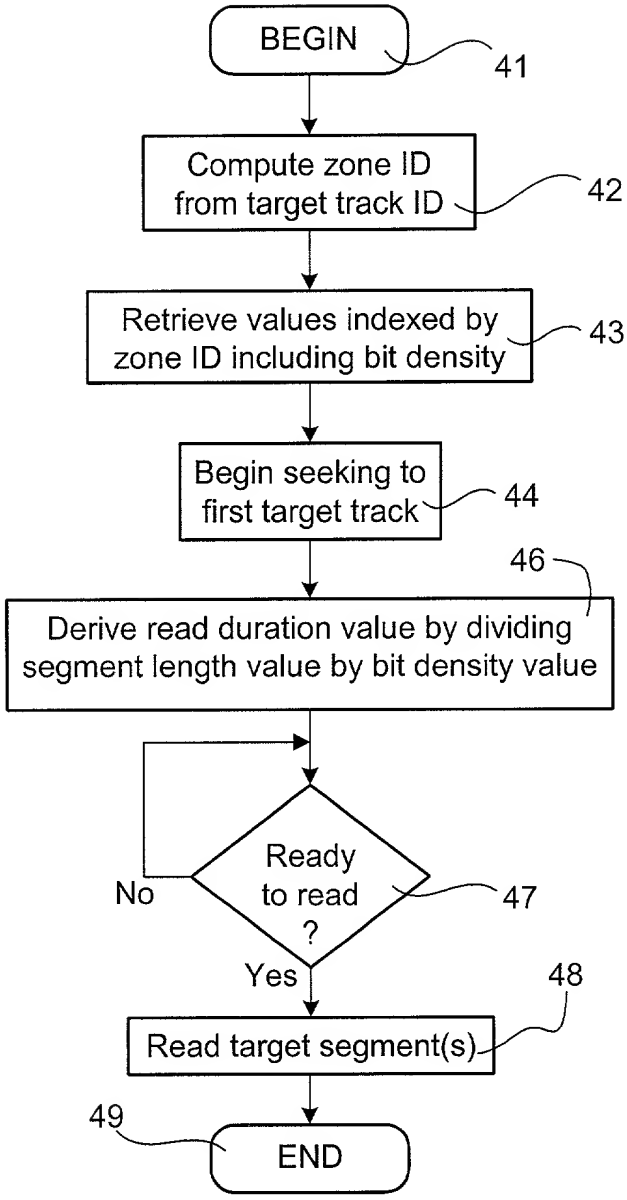
BEGIN
41
Compute zone ID from target track ID
42
Retrieve values indexed by zone ID including bit density
43
Begin seeking to first target track
44
46
Derive read duration value by dividing segment length value by bit density value
Ready to read ?
47
No
Yes
48
Read target segment(s)
49
END

Fig. 7

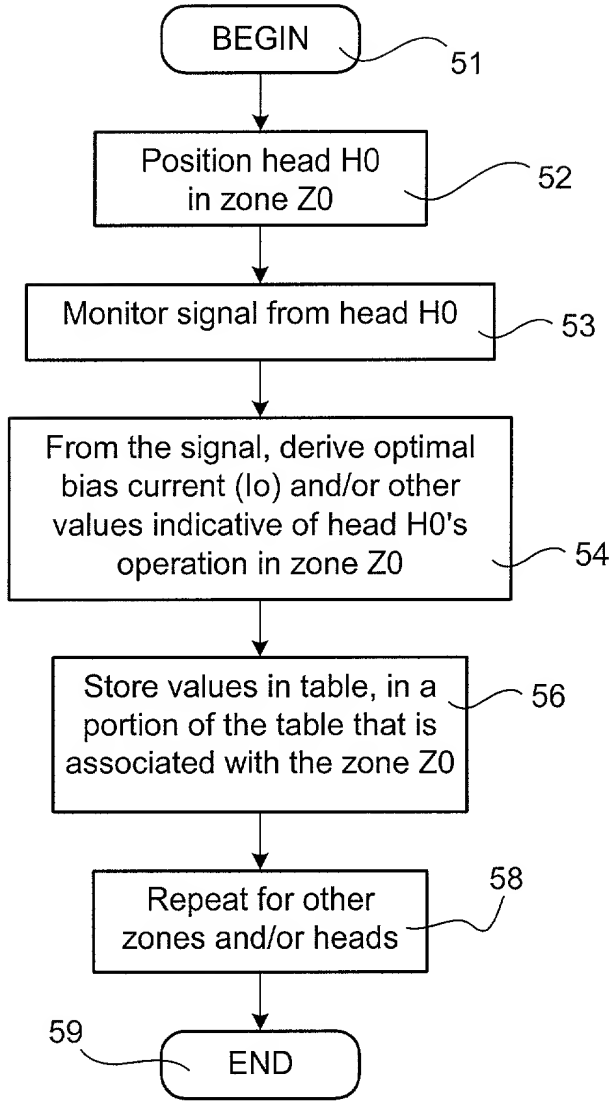
BEGIN
51
Position head H0 in zone Z0
52
Monitor signal from head H0
53
From the signal, derive optimal bias current (Io) and/or other values indicative of head H0's operation in zone Z0
54
Store values in table, in a portion of the table that is associated with the zone Z0
56
Repeat for other zones and/or heads
58
59
END

Fig. 8

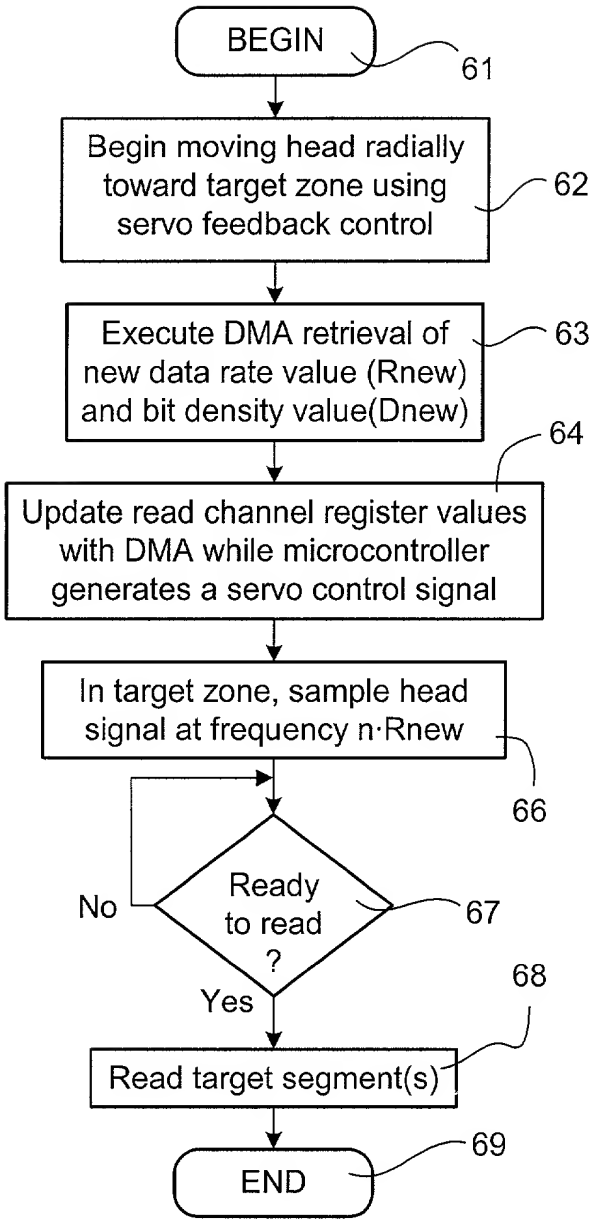
BEGIN
61
Begin moving head radially toward target zone using servo feedback control
62
Execute DMA retrieval of new data rate value (Rnew) and bit density value(Dnew)
63
64
Update read channel register values with DMA while microcontroller generates a servo control signal
In target zone, sample head signal at frequency n·Rnew
66
Ready to read ?
No
67
Yes
68
Read target segment(s)
END
69

Fig. 9

Please type a plus sign (+) inside this box → [+]

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Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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DECLARATION — Utility or Design Patent Application

I hereby claim the benefit under 35 U.S.C. 120 of any United States application(s), or 365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application or PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number (If applicable)

☐ Additional U.S. or PCT international application numbers are listed on a supplemental priority data sheet PTO/SB/02C attached hereto.

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OR

☐ Registered practitioner(s) name/registration number listed below

Name	Registration Number	Name	Registration Number
Jonathan E. Olson	41,231	Raghunath S. Minisandram	36,683
Shawn B. Dempster	34,321		
Edward P. Heller	29,075		

☐ Additional registered practitioner(s) named on supplemental Registered Practitioner Information sheet PTO/SB/02C attached hereto.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name of Sole or First Inventor: ☐ A petition has been filed for this unsigned inventor

Given Name (first and middle [if any])	Family Name or Surname
John Arthur	Mount

Inventor's Signature	John Arthur Mount					Date	1/31/00
Residence: City	Longmont	State	CO	Country	U.S.A.	Citizenship	
Post Office Address	3214 Mariner Ln						
Post Office Address							
City	Longmont	State	CO	ZIP	80503	Country	U.S.A.

☐ Additional Inventors are being named on the ___ supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto

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DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

[X] Declaration Submitted with Initial Filing OR [ ] Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16(e)) required)

Attorney Docket Number	SEA9274
First Named Inventor	John Arthur Mount
COMPLETE IF KNOWN	
Application Number	60/150,712
Filing Date	January 31, 2000
Group Art Unit	
Examiner Name	Unknown

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

AUTOMATED REGISTER DATA TRANSFER RESPONSIVE TO ZONE TRANSITION EVENTS IN A DISC DRIVE

(Title of the Invention)

the specification of which
[X] is attached hereto
OR
[ ] was filed on (MM/DD/YYYY) [ ] as United States Application Number or PCT International Application Number [ ] and was amended on (MM/DD/YYYY) [ ] (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	NO
			[X]	[ ]	[ ]
			[ ]	[ ]	[ ]
			[ ]	[ ]	[ ]
			[ ]	[ ]	[ ]

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Application Number(s)	Filing Date (MM/DD/YYYY)	
60/150,712	08/25/1999	[ ] Additional provisional application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

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